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A Field Guide to the Geology of Franklin Park

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FIELDTRIP GUIDE TO THE GEOLOGY OF FRANKLIN PARK

Bedrock Geology.

Franklin Park abounds in ledges, or outcrops, of "puddingstone", referred to more technically by geologists as the Roxbury Conglomerate. The Roxbury "puddingstone", aptly named in a lengthy and imaginative poem by Oliver Wendell Holmes describing its origin in poetic terms,* is characterized by rounded "plums" of the pudding which consist of a variety of rock types. The color of the puddingstone varies from gray to green and in places maroon. A mottling effect, which gives a certain pleasant visual variety, is provided by the colors of the "plums", which are variously pink, buff, green, gray and black.

The Roxbury Conglomerate is a sedimentary formation consisting of eroded fragments of older rocks. These layers contain evidence that their gravels, sands, silts and muds were deposited, some 600 to 570 million years ago, by water of streams and rivers flowing from the foothills of a nearby Himalayan-like mountain chain (Fig. 1) that lay to the south and west of the basin of deposition. The "plums" of these one-time river gravel deposits consist of gray to white quartzites, red to green volcanic rocks, gray to pink granites, and gray to black mudstones. These rocks and related formations have been more fully described in a book, Puddingstone, Drumlins and Ancient Volcanoes: A Geologic Field Guide along Historic Trails of Greater Boston authored by one of us (JWS,S.J.). *

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* Entitled "The Dorchester Giant", it was published in 1836 in a volume called Poetry. In 1859, Holmes brings up puddingstone again in his book of essays, The Professor at the Breakfast Table.

Glacial Geology.

The Park abounds also in features deposited or produced near the end of the latest Pleistocene glaciation epoch, some 10,000 years ago. These features consist both of those deposited by the melting glacier, such as glacial erratics (Figure 2;Localities 6,7,and 8;), and those that are erosional, such as the glacial scratches or grooves on the polished bedrock surface (Locality 1). This blanket of unconsolidated glacial material forms a soil cover over those parts of the bedrock that are not exposed at the surface. It is this soil cover in which the grass, shrubs, and trees are rooted.

Geologic Setting of Franklin Park.

The rock formations of Franklin Park belong to the Roxbury Conglomerate formation and more specifically to the Brookline member (Figs. 3 and 4). In turn the Roxbury makes up a part of the Boston Bay Group of sedimentary and volcanic rocks. Figure 4 shows diagramatically where the Brookline member fits into the buildup of this great thickness of

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* This book is available to the readership of this paper at the special price of $3.00(postage included) as follows: WesStone Press, Box 561, Dedham, MA 02026, by mentioning that you saw this Bulletin. The regular price is $4.00.

layered rocks. These rocks, now known to be between 600 and 570 million years old, rest on the Mattapan Volcanic Complex from which an age date of 600 million years has recently been obtained. These rocks in turn rest on the 630 million year old granitic rocks of the Dedham Plutonic Complex (Fig. 1). The Dedham rocks, although not exposed as ledges in the Park, are represented as pebbles and cobbles, that is, as "plums" in the puddingstone, having been eroded from the high mountains formed of Dedham granite and transported into the basin of deposition as suggested by Figure 1.

Glacial erratics, a special feature of this Park, were used by architect Frederick L. Olmsted to great advantage, especially in the Wilderness section (Figure 2, Localities 6,7,and 8.) These are large, sub-angular to rounded, commonly polished, loose blocks of puddingstone. They rest on ledges of puddingstone and reach heights of up to 15 feet. One such erratic on Circuit Drive (Figure 2;Locality 8), is one of Nature's many ornaments which the architect of the Park wove into his masterpiece. Such boulders are called "erratics" to suggest that these rocky objects have "wandered off" from their place of origin in the rocky ledges, with, of course, some help from the glacier, and have come to rest in their present location when the ice, in which they were embedded, melted.

Similar in origin to erratics, the ground moraine formed as a soil blanket of irregular thickness on the bedrock surface. These smaller sized particles of eroded rock materials were deposited from the ice as it melted. However, only in small, isolated, temporary excavations can one observe the materials of the moraine. These deposits consist of pale-orange to gray soils, and are composed of rock particles which range from the size of very fine rock flour, to silt and sand sizes, with pebbles to cobbles forming "plums", not entirely unlike those in the ledges of Roxbury puddingstone. However, the glacial deposits have not been lithified, or turned to stone, as has been the case with the hard bedrock. One may recognize the ground moraine by the characteristic presence of erratic boulders scattered over the ground surface, particularly at intermediate levels bewteen the valley bottoms and the exposed bedrock ledges that typically form the tops of hills.

Glacial grooves or striations are scratches or polished grooves on the surface of the bedrock (Figure 2; Locality 1). They have been produced when the glacial ice, containing blocks of rock of varying size, moved in a southerly to southeasterly direction over the Boston landscape. The glacial ice, armed with these stone "chisels" along its base, acted like a gigantic sculptor chiseling linear grooves or streaks on the bedrock surface. These striations are a record of the direction in which the ice moved, the direction varying locally from place to place in response to the shape of the bedrock over or around which the ice had to move. As the ice, filled with smaller grains of rock, moved over the bedrock, it imparted a smooth polish still visible in many places in the Park, especially at Locality 1, where the rock is very fine-grained and therefore suitable to developing a glassy polish.

Roche moutonée, a french word referring to the general similarity in shape of rock outcrops to the backs of sheep, are well developed in the

Park and especially so in Crouch Woods (Fig. 2). Such glacially polished outcrops typically slope gently upward to the south in the direction toward which the glacier moved. However, the lee or south side of the outcrop is much steeper, dropping off in steps, also glacially polished. The steps were produced by the plucking action of the ice, which quarried blocks of the puddingstone and transported these newly formed erratics to their final resting place during this cycle of erosion.

Glacial lake deposits of small size probably occupy the valley bottoms, especially so in the lowland near Scarborough Pond. The morainal deposits of the lowlands are covered by these lake deposits which make up much of the golf course. The landscape there differs from the higher, moraine-covered slopes by the absence of erratic boulders which are abundant elsewhere. Although such deposits are not exposed to view, typical materials are probably present in these lowlands. These include lake bottom gravels, sands, and silts such as are well displayed in gravel pits around the Boston area. Similar deposits have been described in the Greater Boston Field Guide for Walden Pond and the area near Concord.

Age and Environment of Deposition of the Roxbury Puddingstone

Oliver Wendell Holmes poetically attributed the existence and location of great lumps of puddingstone to the rude behavior of youthful giants from Everett who threw lumps of pudding at other young giants from Roxbury. Our explanation, although somewhat deficient in poetical expression, is, we believe, one that is not only scientifically based but is also full of beauty and grandeur.

The age of the Roxbury and associated rocks has been subject to much uncertainty for more than a hundred years. However, as the result of recent research by Robert L. Zartman and Clifford Kaye of the U.S. Geological Survey, and by Cecelia Lenk and associates of Harvard University, it now appears certain that the puddingstone was deposited between 600 and 570 million years ago. Zartman has made isotopic age determinations of the Mattapan volcanic rocks on which the Roxbury Conglomerate was deposited. He determined that the Mattapan is about 600 million years old.

Lenk and her associates of the Paleobotanical Laboratory of Harvard analyzed some small fossil remains in rocks of the Cambridge (Fig. 3) mudstone (technically called Argillite) from excavations near Porter Square in Cambridge along the tunnel for the Red Line Extension of the MBTA. The Cambridge Argillite, in part interfingers with, and in part overlies the Roxbury Conglomerate (Figs. 1 and 5). Together these two formations may make up over 18,000 feet of sedimentary and volcanic rocks. The life forms in the Cambridge Argillite were discovered initially by Clifford Kaye and analyzed by Miss Lenk and other members of the Harvard Group. They determined that these microscopically small life forms are characteristic of rocks in other parts of the world which were deposited between 600 and 570 million years ago. Thus we conclude the the Roxbury Conglomerate is also of that age.

The much finer grained Cambridge mudstone, to which we have just referred, is a sedimentary rock composed of sand and silt size particles arranged in layers. Estimates of its thickness vary greatly from a minimum of 2000 feet locally to a possible maximum of more than 18,000 feet. The Roxbury Conglomerate is the dominant bedrock formation in the southern and southwestern part of the basin, where it was deposited on a valley floor by streams and rivers flowing east and north into an ocean-connected deep water basin (Fig. 1) from high mountains, probably these melted and thereby receeded back over the New England landscape modifying its surface features.

The latest glacier which covered New England , including the Boston basin, is called by geologists the Wisconsin Glacier, named for that state where its deposits and features have been well studied. The length of that glacial period is estimated to have been about 80,000 years. Clifford Kaye, an expert on the glacial geology of Boston has evidence from Carbon-14 dating techniques to suggest that the Beacon Hill moraine has an average age of 20,000 to 17,000. The youngest clay deposits in Boston contains fossil barnicles whose age has been analyzed to be about 14,000 years before present. The final melting of the latest glacial ice from the Boston area is later than the age of this clay and, therefore, may have melted back toward northeastern Massachusetts and northern New England in the vicinity of 10,000 years ago. We may picture the ice cap of that time as having much the same appearance as the Greenland or Antarctic ice cap of today.

Geologic History of the Region in a plate tectonic setting.

The Boston Basin area, of which the Franklin Park is a part, is an integral part of the geology of southeastern New England. This region, however, is quite different geologically from the rest of New England.

Southeastern New England is referred to as a part of the Avalonian terrain or microcontinent, by which we mean that geologically it is much more similar to the geology of the eastern part of the Maritime provinces of Canada, of southern Ireland, Wales, southern England, western Europe, and northwestern Africa than it is to western New England, to which it is now attached.

The rocks of the Boston area and southeastern New England (Fig. 1) are dominantly igneous plutonic and volcanic rocks, and sediments derived by the erosion of these once molten materials. In other words, we interpret the Avalonian terrain of the Boston area as having been part of a volcanic archipelago during the time period from about 900 to about 570 million years ago, perhaps not unlike the Japanese archipelago off the coast of Asia today. There is evidence that the Avalonian archipelago or microcontinent lay closer to Africa than it did to North America at the time of its formation. Data from our research suggest that movement of gigantic continental and oceanic plates split up and transported the Avalonian microcontinent from its original position offshore of Africa to positions along the eastern seaboard of North America, western Europe and northwestern Africa as illustrated in Figure 6.

These movements resulted in a collision of the Avalonian microcontinent with the North American plate and produced a mountain chain similar in height to the Himalayas. We envision the Avalonian plate, or microcontinent, as being somewhat similar to the Indian plate which has

Father James Ring discusses a salient outcrop of Puddingstone on Pierpont Road during his May 4, 1981 Geological Walking Tour of Franklin Park.

A Rustic Fountain on the Playstead Overlook. Built about 1889, the Fountain is made of chunks of puddingstone dug up on site.

Two huge Puddingstone boulders in the Wilderness near the Picnic Grove. These may well have been placed by F. L. Olmsted during the landscaping of the Wilderness walks and drives between 1890 and 1892.

moved from near eastern Africa to collide with Asia. In the process the leading northern edge of India has been overridden by the Asiatic continent. The result is that this collision has produced exceedingly high mountains. Similarly in the collision of the Avalonian microcontinent with eastern North America, a great mountain belt of Himalayan size and height developed in eastern North America. The "Mount Everest" region of those times in New England, 275 million years ago, was undoubtedly located in central Massachusetts, Connecticut, New Hampshire, Vermont, and southwestern Maine. The rocks exposed at the present day surface there indicate that they were formerly depressed to greater depths beneath the surface than the rocks of other parts of New England. This implies that they have come back to the present surface as the result of rapid erosion due to enormous uplift of the Appalachian mountain chain.

Walking Guide to Specific Localities

General guidelines. All bedrock outcrops in Franklin Park belong to the oldest member of the Roxbury Formation, called the Brookline member (Fig. 5). It is distinguished from the Dorchester member by containing a higher percentage of puddingstone whereas the Dorchester conatins a greater abundance of finer grained layers such as siltstone and sandstone. Most of the outcrops on this walking tour show variations in the same features of texture, composition and styles of deposition, as well as a variety of glacial features or deposits of the Pleistocene ice cap. Eight of the stops are located near Pierpont Road (Fig. 2). A

Localities 2 and 3. Climb up on the outcrops of puddingstone where features described under Locality 1 may be seen from a slightly different perspective. The smoothed and polished steps on the lee side of the outcrop, developed by the plucking action of the ice in the process of formation of roche moutonee, are well developed. Joints, which are fractures cutting through both pebbles and matrix alike, are features that have been developed in the rocks following their lithification. It is the presence of such fractures that permitted blocks of various sizes to be plucked out of the bedrock by the glacial ice.

Locality 4. This is a low ledge on the right side of Pierpont Road facing the stadium. Here there are some larger than ordinary pebbles; the rock has undergone some discoloration due to groundwater moving through fractures in the rock. We infer that the lowland under the playing field is probably the site of a fault, or ancient zone of earthquake movement, during which movements the bedrock underwent fracturing, giving rise to the cracks along which the groundwater could move. From this vantage point one may see in the lowland the glacial moraine deposits which cover the bedrock. The cliffs of rock represent that part of the continuous bedrock that was not permanently covered by glacial deposits, even if they may have been once more extensive than at present.

Locality 5. A large boulder of puddingstone some 5 feet in diameter, is one of several glacial erratics that may be examined in this part of the Park. The Wilderness area in general is covered with an abundance of erratics which range up to 15 feet in diameter with 6 feet being fairly common.

Locality 6. At the foot of the hill approaching the comfort station,there are puddingstone outcrops which also show many of the individual features that were noted above in the text and in the previous localities as well.

Locality 7. One of the larger glacial erratics is present in the woods.

Locality 8. At the edge of the parking lot on Circuit Drive, opposite Schoolmaster Hill, is a large glacial boulder whose classical development as an easily recognizable and photogenic glacial erratic is increasingly obscured by the growth of a tree, which is encroaching on the space of this magnificent relic of the melting Pleistocene ice cap some 10,000 years ago. From this viewpoint you may look to the south and southeast across the golf course in the lowland. This area is covered by glacial moraine, and may be recognized generally by the presence of boulders, except where these have been removed in the process of construction of the Park. The moraine deposits of the lower slopes probably have been covered by finer grained materials without boulders, very likely a glacial bottom deposit.

Locality 9. This locality is located on the crest of a hill about 200 feet west of the Picnic Area overlooking the Arnold Arboretum and vicinity beyond Forest Hills Station. From here there is a good view of Peter's Hill, a drumlin in the Arnold Arboretum, a locality described in the Boston Field Guide mentioned above. To the south a few hundred feet you may observe that the landscape falls off very rapidly to a stream valley. Here one gains an impression of the rapid variation from hills to valleys produced in part by pre-glacial erosion. However, the overdeepening of the valley profiles may be due to erosion along fractured and leached rock possibly marked by a fault.

In conclusion we wish to note that although Franklin Park has only one member of the Roxbury Conglomerate represented in the ledges which abound here, a great variety of features in the bedrock and in the Pleistocene glacial deposits may be seen no matter where one may choose to take a walking tour. We have picked one part as a sample of geological features that are of specialinterest to us. We hope that the history which these rocks preserve may be of interest to all of you who come to share in the fresh air, sunshine, great beauty, and grandeur of this Park, designed by one of the great architects of public parks Frederick L. Ohlmsted.

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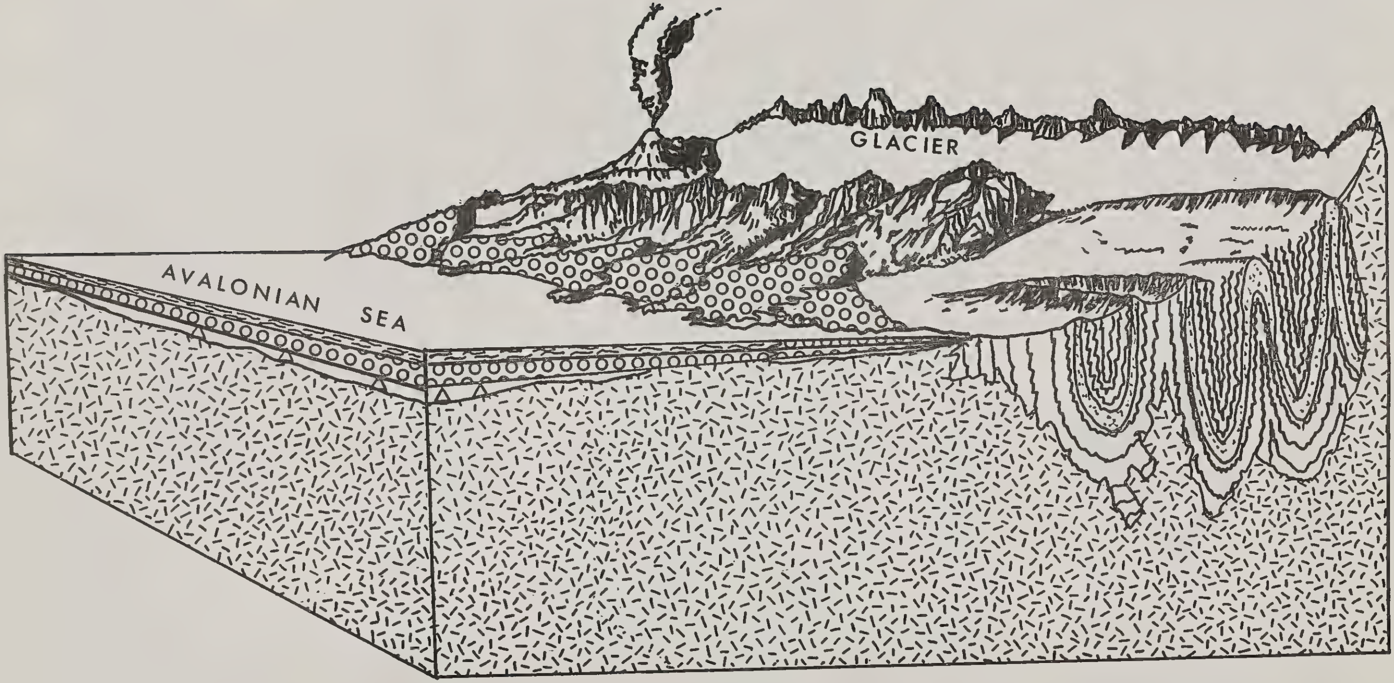
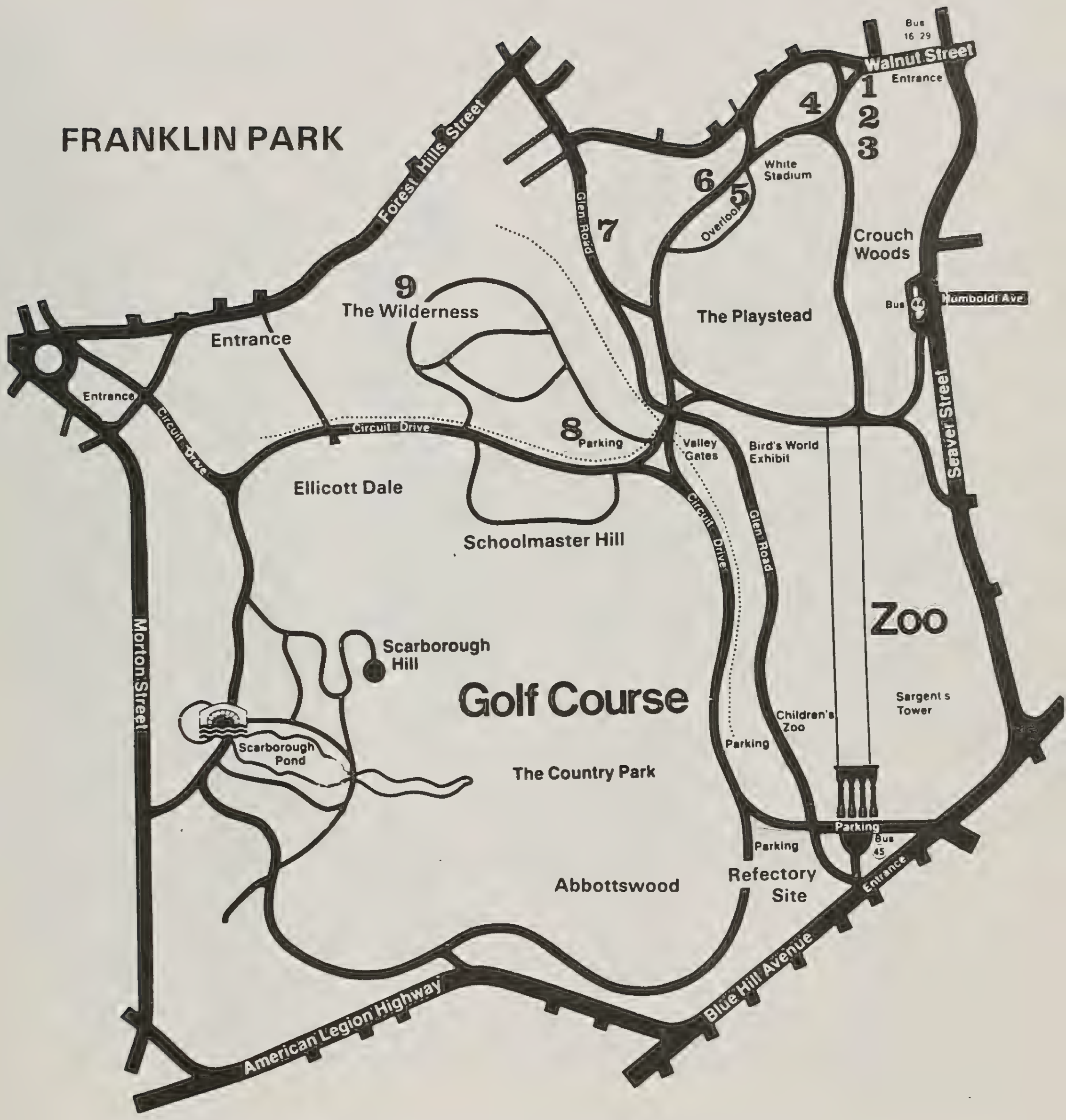
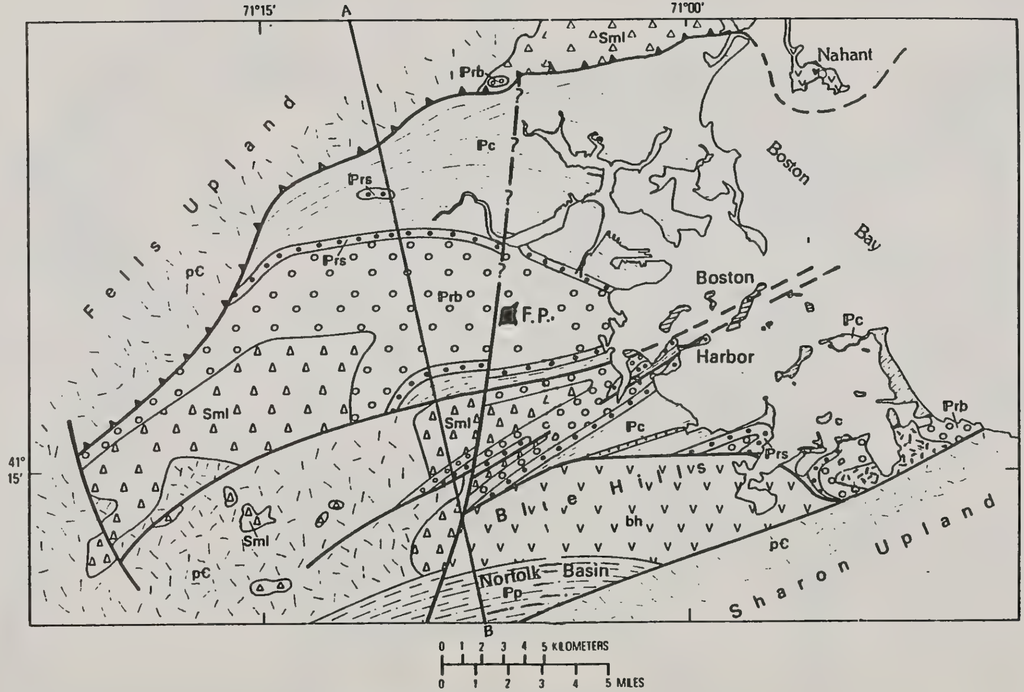


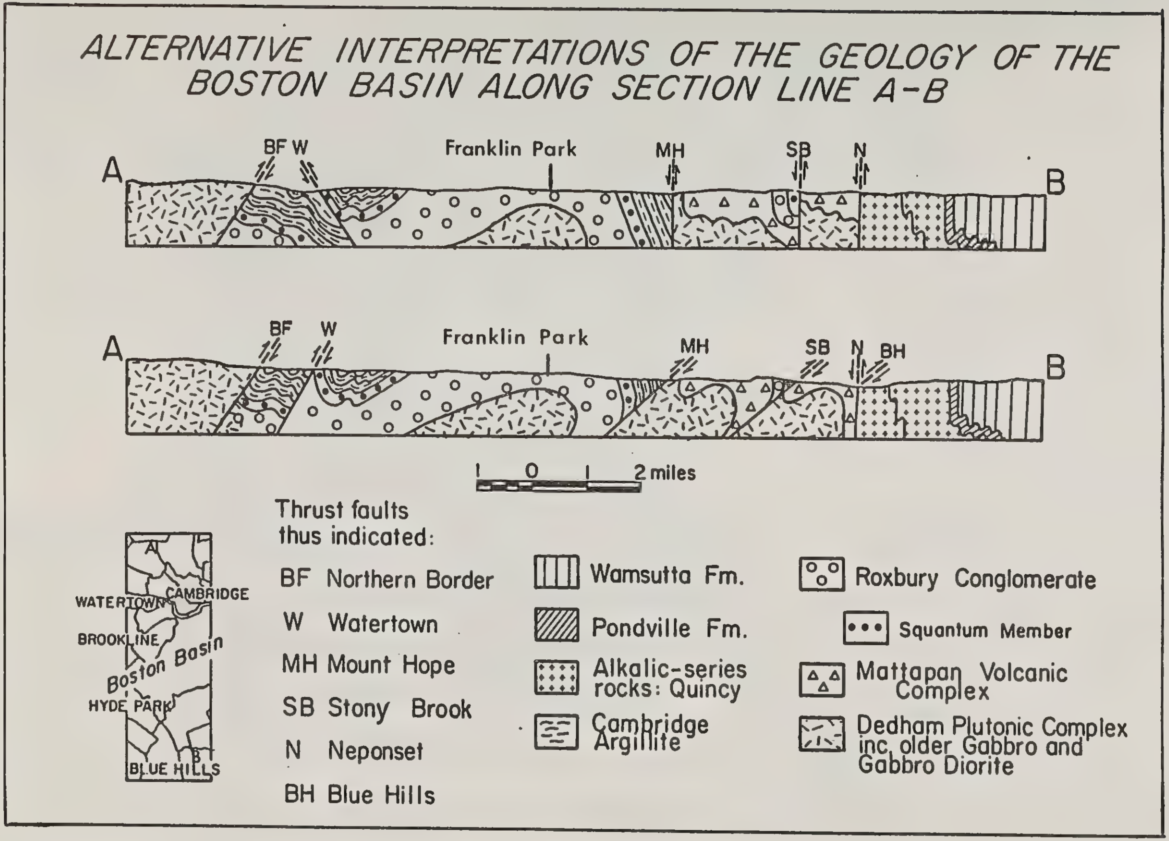
1. Block diagram showing the Boston area as we picture it to have been when the Roxbury "puddingstone" was being deposited. Note the high volcanic mountains in the background partially covered by mountain glaciers, whose meltwater streams and rivers carry rock fragments into the nearby ocean basin, which we have named the Avalonian Sea (modified from David Rahm, 1958).



2. Map of Franlin Park showing specific locations described in the text and localities of the Walking Guide.

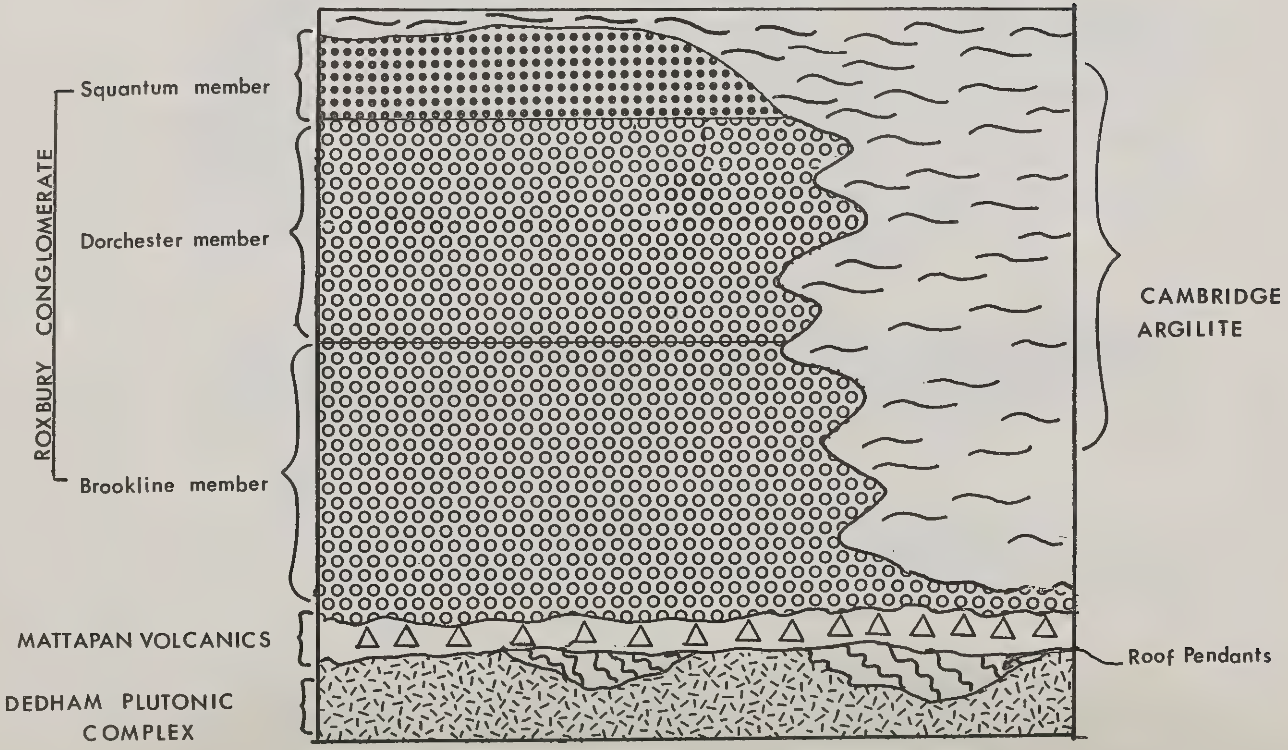


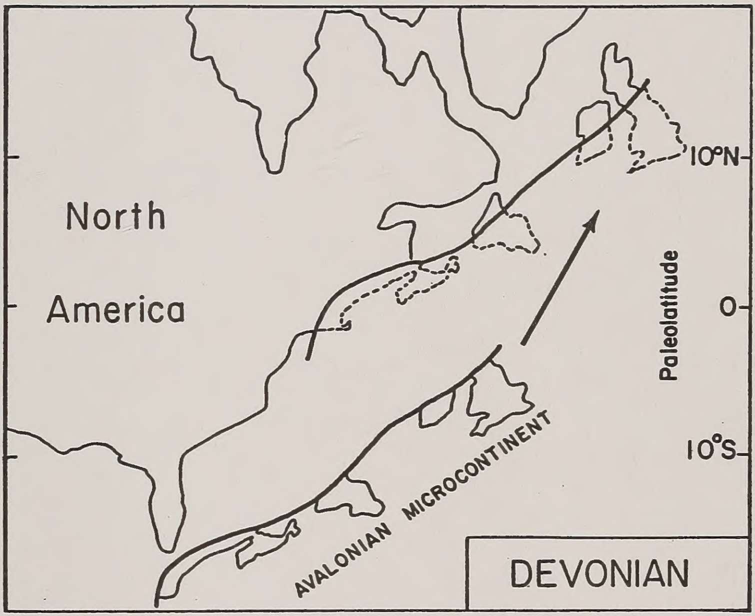
3. Geological and location map of the Boston Basin area (from Marland P. Billings, 1979).



4. Geological cross section through the Boston Area showing the approximate geological setting of Franklin Park and vicinity;the sequence in which the various rock formations were formed is indicated in the table of symbols and in the stacking order of layers from bottom to top. The upper cross section is the interpretation of Marland P. Billings, 1976 and 1979; the lower cross section is the interpretation of James W. Skehan, S.J., 1978 (from James W. Skehan, S.J., 1978).

5. Stratigraphic column of the Boston Bay group showing the several members of the Roxbury Conglomerate relative to other rock units.





6. Map of North America and the Avalonian microcontinent, part of which now comprises the eastern seaboard of North America, southern Ireland, the southern British Isles, as well as parts of western Europe, and northwest Africa. This map represents the relative positions of North America and the Avalonian microcontinent approximately 350 million years ago as determined by interpretation of paleomagnetic data. Note that at this time the Avalonian microcontinent and about half of North America were south of the equator(from Dennis Kent and Neil Opdyke, 1978).